

Medical and Pharmaceutical Sciences to Enhance and Suppress Memory and Attention in a
Science Fiction Framework

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Abstract

Memory and attention are essential cognitive functions for everyday life. Some may ponder what it would be like to live in a society where memory and attention are severely heightened or impaired by drugs. Science fiction novels and films have successfully sold their audiences on the possibilities of such a society while also warning the moral and ethical considerations. This paper explores the tumultuous relationship between medicine and science-fiction, where drugs can miraculously enhance or suppress memories and attention. With such capabilities, this may involve enriching one's memory to the smallest of details to carry out extraordinary tasks or completely stripping one's memories to commit heinous crimes. Drugs with this phenomenal potential seem remarkable in theory; however, it is currently improbable — though there is ongoing medical research in neurodegenerative diseases targeting the progression of memory loss. While drugs used to treat cognitive illness are essential to maintain quality of life, the moral and ethical implications of science-fiction (superhuman qualities) based drugs are deemed controversial; the abused uses of unregulated cognitive enhancement would ultimately create even more inequality in society.

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In order to catch the attention of millions and make lucrative profits, the film and publishing industries have centered their stories around seemingly unattainable technology and or superhuman powers. Although what we watch and read may sound implausible, much of the inspirations stem from legitimate science — the elements of science fiction are essentially heightened science. A leading inspiration science fiction creators pull from includes but are certainly not limited to medicine, such as the pharmaceutical industry. In many young-adult targeted projects, a popular trope centers around a newfound drug that aims to structure a utopian society. This review goes into a deep analysis of *Less than a hero* (Brown, 2015), *Limitless* (2011), *Marcel Proust, Incorporated* (Dalrymple, 2017), *The Fourth Profession* (Niven, 2003), *Lest We Remember* (Asimov, 1982), and the intersectionality between medicine, science-fiction, and memory and attention. While the memory-enhancing medications have fruitful capabilities, it raises moral and ethical questions that need to be considered.

A typical science fiction trope uses medicine or technology to heighten one's senses to save society: *Less than a hero* (Brown, 2015) does just that. This satirical novel uses mediocre heroes to comment on the corrupt and broken American healthcare system, all while incorporating psychological themes of memory and attention. The protagonist, Lloyd, makes his living by participating in prescription drug trials. Along with his friends, he takes newly developed drugs to help pharmaceutical companies discover potential side effects. As the novel progresses, he notices that one of those common side effects, drowsiness, has not only increased but can be projected, causing people around him to fall asleep. Comparing side effects, the friend group realizes that they have all developed similar powers (inducing seizures, diarrhea, vomiting,

etc.) and decide to team up together to fight crime. Meanwhile, in New York, two antagonists developed obscure powers from the clinical studies and commit crimes by stealing citizens' memories and making them hallucinate.

Both *Less than a hero* and current scientific literature discuss drugs with memory-altering effects (Otis et al., 2014); however, it does not seem very plausible to develop a drug that can allow individuals to steal other people's memories or project hallucinations. Such drugs would be considered borderline telepathic enhancements — the ability to transmit information from one's mind to another's — and this line of research has not made much significant impact. Despite the lack of drugs with the ability to broadcast memory loss (on others), there are non-drug related treatments that may be used to erase memory, such as electroconvulsive therapy (ECT); if one desires to make purloining memories into a reality, a first step would be to figure out the mechanisms necessary to control one's mind. Then, compute the neuronal interactions using theoretical neuroscience and then translate the mathematical computations to develop drugs. However, proper medicinal drugs for memory-erasure projection are currently improbable.

Fictional drugs that produce the ability to “steal” memories are somewhat in parallel to beta-blockers used for treating Post-Traumatic Stress Disorder (PTSD) (Evers, 2009). During a traumatic event, stress hormones (notably epinephrine and norepinephrine) are released in the amygdala. They can give rise to such powerful memory formation where traumatic memories cannot be forgotten. In a situation where an individual seeks medical treatment to cope with unwanted memories, it is not uncommon for patients with PTSD to take beta-blockers. In *Less than a hero*, the criminals can get away with robbing citizens by stealing their victim's memory which also removes any potential trauma associated with the robberies; akin to the criminals, beta-blockers can prevent the onset of PTSD by blocking the stress hormones before the memory

of the traumatic event consolidates and becomes emotionally triggering (Evers, 2007) — the differences are that beta-blockers will not allow an individual to project its abilities onto others (as criminals can), only treat their own memories.

The concept of stealing memories is beyond unethical; hence this is why it is an antagonist — not a protagonist — power. If the pharmaceutical industry were to make this a reality, chaos would ensue. Crimes such as theft, vandalism, abuse, and plagiarism, would be on the rise. However, stealing someone's memories may be in good faith; this raises a philosophical question: can one steal another's memory to protect them from trauma? Perhaps the ability to take away someone's memory may be used as a form of therapy, but the abuse outweighs the potential benefits.

Another example of medicine in science fiction can be seen in the film *Limitless* (2011), a film adapted from the 2001 book by Alan Glynn, *The Dark Fields*. The main character Eddie is given a pill, and he ingests it. The drug metabolizes, and the film suggests that Eddie's memory capacity has opened like a floodgate and can encode stimulus information that would not typically encode in our memory. He notices different behavioral cues, or micro-expressions, of a momentary antagonist who is generating a conflict with him. With all his new attention to detail, boundless memory capacity, and effortless and immediate encoding and retrieval, Eddie is able to recall a random memory from 12 years prior and integrate that memory into a less confrontational conversation with the antagonist. The hyper-awareness that is depicted in this scene is akin to some literature on PTSD and hypervigilance, focusing attention on potential threats and maintaining a forward feedback loop (Kimble et al., 2014). Some side effects of withdrawal from NZT were headaches, nausea, lack of motivation, lack of focus, or death. Essentially, this movie revolves around a drug that gives one access to stronger mental faculties,

increasing memory encoding and retrieval, focus, attention, critical thinking, and creativity. The mystery drug is not realistic. In the movie, anyone can benefit from taking the drug, and its benefits are compounded when the individual was smart before taking it. There are medications that may show some evidence of one or more of these increased cognitions, but results vary, and different medications target different populations. Contemporary Alzheimer's medications are usually limited to helping curtail some cognitive decline in patients by how much is unknown (Fedele & Ricciarelli, 2021). Individuals who have ADHD and use the stimulant as prescribed show increases in several behavioral and psychological outcomes. However, the risk to oneself increases dramatically for individuals who misuse ADHD medication, either by not having ADHD and consuming ADHD medication anyways or being prescribed ADHD medication and then abusing it (Lakhan & Kirchgessner, 2012).

In *Marcel Proust, Incorporated* (Dalrymple, 2017), we see an interesting plot develop, paralleling some of the topics we have discussed in class. This short story takes place in an era where federal educational loans have been turned over to the industry. The same way that the bank will try to repossess your property if you do not make the payments, within this story, there proves to be interest in repossessing people's educations. Students own a "renewable license" to their college education, so long as their loans are in good standing. There is a revolutionary drug that improves long-term memory up to 15x, regardless of prior IQ. It uses our olfactory senses to initiate a state of super-memory. In the story, the author suggests that olfactory stimuli are processed more quickly than visual stimuli and can process through the amygdala faster. The drug, Proust, does not have any negative side effects. However, there have been claims that people who stopped taking Proust, or more descriptively stopped having access to Proust, have lost most if not all of the long-term memories gained while taking the drug. Some took Proust for

their entire college educations. When a student loan is defaulted on, Proust is denied to that student, and all their memories gained while on the drug fade away. Now banks have a way to repossess peoples' educations. Proust is far from plausible right now, as much of the literature on memory-enhancing drugs in conjunction with Alzheimer's Disease is minimal at best. Although animal models have provided fruitful results in preclinical trials, Fedele and Ricciarelli (2021) suggest that future clinical trials are necessary to find the right dosage for different cohorts and investigate combination therapies. Further clinical studies are necessary to investigate the connection between therapies, interventions, and medications.

There is a common misconception that stimulants can be used as performance enhancers. A literature review by Lakhan and Kirchgessner (2012) looks at the few experiments that focus on cognitive improvement effects of stimulants on participants with and without ADHD. Both MPH and d-AMP are the most widely used prescription stimulants for ADHD. Lakhan and Kirchgessner state, "Although the precise mechanisms underlying the action of these medications are not completely understood, they appear to increase the availability of dopamine". ADHD has often been illustrated as an attention deficit, but growing evidence suggests that a reward and motivation deficit may be equally important. Through their review of the relevant literature they found, stimulant medications do not necessarily equalize academic achievement in the typical adult with ADHD. When ADHD studies look at cognition, they usually show performance improvement post-treatment. However, treated patients perform better than untreated patients but are still impaired compared with normative subjects. Even during optimal treatment, neurocognitive impairments caused a deficit in ADHD patients when compared to non-afflicted patients. In *Limitless*, we see a miracle drug that enhances the cognitive ability of everyone who takes it. This is much different from studies with ADHD

medication where patients still do not perform at normative non-afflicted levels. We also see some negative consequences of substance abuse, and although it is science fiction, there are some similarities in negative side effects with potential complications of ADHD medication use without ADHD. There are many experiments that have concluded on the positive effects associated with the proper use of ADHD medications as well (Chang et al., 2019).

The Fourth Profession (Niven, 2003) demonstrates the concept of memory enhancement similar to *Limitless*, but with an incredibly significant development. This short story hones in on a Hollywood bar called the Long Spoon Bar. The protagonist, Edward Frazer, wakes up with a hangover after serving drinks to customers the previous night. He is confronted by a Secret Service agent, which begins the recollection of the events that transpired. After pondering what occurred with the agent, the two come to the realization that the “monk” that Frazer was serving was an alien that excelled as a merchant of memory manipulating pills. By ingesting one of these pills, the individual can immediately become a full-on expert in just about any topic, ranging from understanding advanced calculus or becoming an Olympic gymnast. The mistake the aliens make in this story is that they give Frazer a pill that teaches him their entire language instantly, allowing him to uncover their plans.

Niven’s concept of immediate memory-altering pills can be further explored by studies on the correlation between emotion and memory. Sharot et al. (2004) has found that the most well remembered memories are those that have been incorporated or originated from a very emotional incident. This information can be combined with studies of the amygdala, an area that focuses on both memory and emotional fight-or-flight responses (Adolphs et al., 2005). When an individual faces a traumatic event, they trigger their fight-or-flight response, and in doing so, causes an almost scar like event that helps engrave this moment into our memory (Sharot et al.,

2004). This is one of the reasons why we remember our most traumatic and even our most cherished memories. The amygdala is the part of the limbic system that enhances memories due to the activation of emotional components (Adolphs et al., 2005). One reason that could cause this is so that we do not waste energy remembering the more “pointless” moments in our lives like using the restroom, cleaning up, making food, etc. The act of remembering the dangerous moments so vividly helps us avoid making the mistakes we made to get to that point or saves the information: if we face that same situation again, we can use what works to get out. The same goes for the happier memories, as if they made us feel euphoric, then we know that is something we want to replicate.

In relation to Niven’s story, the aliens may have utilized adrenaline and dopamine. Adrenaline is mainly involved in the activation of fear — it opens up oxygen pathways to muscle and respiratory systems and enables a faster transportation of oxygen and necessary hormones to traverse the body fast enough. Essentially, adrenaline gives the individual the ability to fight off or flee from the one who triggered the response (Goldstein, 2010). Dopamine, however, is used as our main reward factor when something goes correctly. By combining both of these areas, one would surely have enhanced memory of that specific incident. The overwhelming flow of adrenaline with an exponential relief from the dopamine would engrave that feeling into our memory as it gives off the impression that a huge accomplishment had just been achieved.

One final example regarding Niven’s story follows the alien’s ability to remove memories with their triangular pills. When Frazer is presented with the pills from his alien merchant, he notices triangular pills that he later finds are used to erase memories. This would be used to forget a concept that an individual learned, such as taking a pill to learn world geography in an instant; the corresponding triangle pill would erase all world geography immediately. Following

Adolphs' research, it would likely utilize some form of manipulation within the amygdala, or possibly even damaging and restoring it. Adolphs found that damage to the amygdala affected emotional components for memory and thus made individuals either forget or, at the very least, struggle to recall memories associated with emotional experiences. This would not substantially affect short-term memory but would make it much more difficult for the individual to recall memories from the past that made them feel happy, scared, sad, etc.

Lastly, the final example of the film and publishing industry centering their stories on seemingly unattainable technology, or in this case, pharmaceutical manipulation, is in the short story, *Lest We Remember* (Asimov, 1982). This story revolves around the idea of enhancing memory and attention through neutralizing the recall-inhibitor. It states that the mammalian brain stores more information than it needs. If it were to recall all the information at once, it would become overwhelmed and never come upon the appropriate reaction in time. This leads for the recall in the brain to be inhibited, which alludes to the characters creating the disinhibitor. The protagonist, Johnny, is injected with the disinhibitor, which allowed him to easily recall anything in his past and made it extremely accessible to learn more difficult aspects as well. He was drawn to be the first human to test this drug, and the scientists did not quite explain the entirety of the side effects. With Johnny wanting to exceed his "dead average" self, it did not take much convincing for him to accept the offer. With very little moderation and quite some freedom, Johnny completely turned against most of his colleagues in his firm.

The question remains on how plausible these science-fiction ideologies are. It can significantly raise curiosity as memory-enhancing drugs, such as the disinhibitor, may sound very intriguing to individuals who have come across trauma that affected their cognitive ability and memory decline. Studies have been completed on rodents to test the reversing of memory

impairment: Chou et al. (2017) discovered a compound, ISRIB, that blocks the stress response in human cells. When tested on healthy mice, it boosted their memory. Wondering if this drug can also reverse memory impairment, they tested mice that suffered concussions and blows to the head's back. They found that after a couple of doses each day for three days in a row, the injured mice were performing as well as the healthy ones. Studies like this can give extreme hope to those who have lost their loved ones to traumatic brain injury that seems irreversible at the moment.

Although there are several drugs that exist that run along the lines of memory and attention enhancement, such as Adderall and Ritalin, which treat Attention-deficit/hyperactivity-disorder (ADHD) and narcolepsy, there are several other drugs anticipating enhancement (Greely et al., 2008). These include the treatment of Alzheimer's disease through raising acetylcholine levels in the brain. However, experimenting with drugs that can alter the human brain to such lengths come with risks and responsibilities. The human brain is the most delicate organ, and anything taken to adjust it should be treated with caution. For example, a drug used to treat dementia may have serious side effects, but the trade-off for treating dementia is worth the risk; however, the trade-off is not safe enough for typical individuals who want to use the drug for enhancement purposes (Greely et al., 2008). When we take a look back on the short story, *Lest We Remember*, pride completely took over, and there was no stopping a man who knew everything. When looking at this side of Sci-Fi and how many risks it can come with if mimicked in the real world, it becomes clear that there are many harmful effects that accompany such modifying drugs.

From the stories discussed in this paper, memory, and attention enhancing drugs are plausible, but not to the extent that science-fiction writers may desire. Such drugs are already

used to aid illnesses such as PTSD (Evers, 2007), ADHD, and Alzheimer's disease (Greely et al., 2008), but are not capable of producing superhuman-like effects on memory. Some modern hurdles can be seen in clinical trials with Alzheimer's medication. Preclinical trials with animal models have shown significant findings (Fedele & Ricciarelli, 2021). However, researchers are still unsure how effective the medication is in clinical trials. There are still questions with regard to the efficacy of medication in conjunction with combination therapies when using the cGMP system. In addition to research hurdles, funding is an issue when it comes to developing drugs. Pharmaceutical companies have severely downsized their research divisions for treating brain diseases (Choi et al., 2014). Limited funding reflects the lack of interest and the growing view that treating brain diseases with medicine is far too challenging.

The utilization of the drugs outlined in this paper exemplifies unethical and immoral behavior: the inevitable consequences that come with drugs providing an artificial and perfect memory include more inequality in society by disproportionately affecting marginalized communities. Due to a growing capitalist society, a drug that can enhance attention and expand memory capacity would be highly expensive, as seen with EpiPens — a medication that many individuals cannot live without. An extreme memory-enhancing drug would not be considered a medical necessity; therefore, the cost would be exorbitant. Only the upper class would be able to afford this hypothetical drug, and employers (especially for high-paying careers, i.e., doctors, lawyers) will be more inclined to offer jobs to people with perfect memories. In addition to the workforce, one may compare this ethical debate with cheating in higher education. If wealthy high schoolers are able to obtain such a drug, they would more than likely perform better than the students who cannot afford it and gain admission to more prestigious universities: which in turn reinforces the wealth disparity.

Science fiction stories have a unique storytelling job that combines science and the audience's dreams and fantasies. It ultimately helps the readers and audience imagine the many possibilities of advancing the sciences to improve quality of life, although some stories are more plausible than others. Furthermore, science fiction also serves as a precaution against technology and medical practices that may further enrich social prejudices and injustices.

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